Report Documentation Page

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14. ABSTRACT

The selection of machining parameters for cutting tool / material combinations is generally based on experience or static databases. In general, these parameters tend to cause the cutting tool and the machine tool to be grossly under utilized. The National Center for Defense Manufacturing and Machining (NCDMM), in conjunction with TechSolve Cincinnati, OH, and General Dynamics Land Systems (GDLS), Lima, OH, have worked together to optimize the machining parameters of three (3) materials chosen by GDLS. These materials are Titanium 6-4, Steel Mil-A-12560, and Aluminum 2519. The optimization database developed by TechSolve, through the efforts of this project, will potentially provide GDLS with a 3-fold increase in machining performance for the M1 tank and other related components.

15. SUBJECT TERMS
Success Stories; The National Center for Defense Manufacturing and Machining; NCDMM; TechSolve; General Dynamics Land Systems; Titanium 6-4; Steel Mil-A-12560; Aluminum 2519

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Intelligent Machining Optimization

NCDMM Project No. 07-0147-07

Success Story

PROBLEM / OBJECTIVE

The selection of machining parameters for cutting tool / material combinations is generally based on experience or static databases. In general, these parameters tend to cause the cutting tool and the machine tool to be grossly under utilized. The National Center for Defense Manufacturing and Machining (NCDMM), in conjunction with TechSolve, Cincinnati, OH, and General Dynamics Land Systems (GDLS), Lima, OH, have worked together to optimize the machining parameters of three (3) materials chosen by GDLS. These materials are Titanium 6-4, Steel Mil-A-12560, and Aluminum 2519. The optimization database developed by TechSolve, through the efforts of this project, will potentially provide GDLS with a 3-fold increase in machining performance for the M1 tank and other related components. In addition, these "optimum" machining parameters will provide the best tool-life, surface finish, material removal rate (MRR), and generate minimal cutting forces. This optimization will be accomplished through a series of detailed design of experiments (DOE) developed by TechSolve and carried out by the NCDMM. The machining operations to be evaluated are face milling, end milling, and drilling utilizing specific Kennametal Inc. tooling.

ACCOMPLISHMENTS / PAYOFF

Process Improvement

To find the optimum machining parameters of the three (3) materials, the NCDMM performed sixty (60) DOE's varying multiple parameters throughout the machining trials. The parameters varied for face milling and end milling were feedrate (IPM), rotational speed (RPM), axial depth of cut (ADOC), and radial depth of cut (RDOC), and the parameters varied for drilling were feedrate (IPM) and rotational speed (RPM). Data collected while performing the non tool-life DOE's were surface finish (R_a-µin), axial and radial cutting forces (F_x-lbf, F_y-lbf), and thrust (F_z-lbf) for face milling and end milling, and thrust (F_z-lbf) and torque (M_o-in-lbf) for drilling. In addition, tool-life testing was also performed. Tool wear (in) was measured and recorded every two (2) minutes for sixty (60) minutes, or until a tool end of life criteria of 0.020" maximum wear was reached. Utilizing the data collected while performing the aforementioned DOE's, and based on TechSolve's Machining Optimization Engine, customized machining optimization software will be developed and implemented at GDLS. By doing so, machine operators will be achieving optimum machining performance. Figure #1 illustrates the most favorable results observed throughout the project. Figure #2 is a representation of Titanium 6-4 DOE.

Table #1

Operation	Material	IPM*	RPM*	ADOC* (in.)	RDOC* (in.)	# Holes	Duration (Min)
Drilling	Ti 6-4	2.28	380	N/A	N/A	91	60
Face Milling	Ti 6-4	2.4	100	0.04	0.05	N/A	60
End Milling	Ti 6-4	6.0	2500	0.20	.0125	N/A	60
Drilling	St 12560	No Favorable Results Observed – Severe Chipping Throughout Trials					
Face Milling	St 12560	19.2	1600	0.10	0.5	N/A	60
End Milling	St 12560	12	3000	0.05	0.5	N/A	60
Drilling	Al 2519	Tool-Life Testing Not Required					
Face Milling	Al 2519						
End Milling	Al 2519						

Figure #1: Tool-Life DOE Machining Trials Most Favorable Results

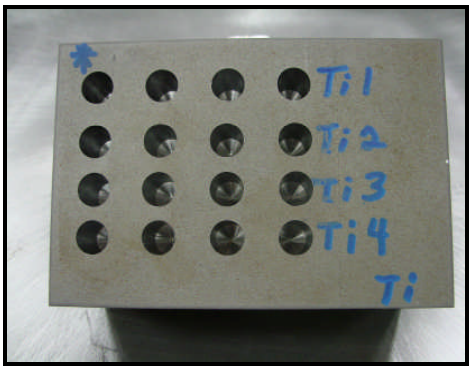

Figure #2: Completed Drilling DOE of Ti 6-4

Expected Benefits

By implementing the resulting data into Techsolve's Intelligent Optimization Engine, TechSolve expects GDLS to experience a 3X increase in productivity over corresponding machining data handbook cutting parameters.

TIME LINE / MILESTONE

Start Date..... August 06
End Date .....January 07

PROJECT FUNDING

NCDMM Funding.....$35K

PARTICIPANTS

Kennametal Inc.
TechSolve